Lead Paint Exposure Assessment in High Bays of Johnson Space Center

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SD3/Occupational Health
Penney Stanch, MS, MPH
Angel Plaza, MS
Sean Keprta, MS, CIH

Purpose

- National Aeronautics and Space Administration (NASA), Johnson Space Center (JSC) , Houston, Texas
- Construction of the “Manned Space Flight Center” (MSC) began in 1962, predating any considerations to reduce lead in paints and coatings
- Many facilities contain “high bays”, open shops and work areas that have open ceilings and structure
- Some of these shops had operations that use or could generate lead dust, - use of leaded gasoline, batteries, lead based paints

Purpose

- High bay ceilings (2 stories or greater) were unlikely to have been repainted during any subsequent remodeling
- Buildings have aged 40+ years since then, especially the roofs
  - Health concern arises only when paint is deteriorated: peeling, chipping, chalking, cracking, or separated from the substrate
  - These aging roofs are leaking, causing deterioration of the paint on the decking
- All high bays subject to custodial activities to maintain cleanliness
- No comprehensive study of particulate or lead in dust

Background

- Building 421 General Supply Warehouse
  - Corrugated sheet metal building , painted , built up flat roof, approximately 47,000 sq ft
  - Receipt of materials, temporary storage until distributed across the center, permanent storage for critical spare parts and hurricane supplies
  - Perform receiving inspections, property management and tagging
  - Bonded storage for flight equipment and materials
  - ~ 30-40 yrs old
    - Gasoline-powered forklifts used in the past, prior to the regulatory phase-down of lead-content in gasoline initiated in 1973
    - Currently have electric forklift operations

Building 421
General Supply Warehouse

Background

- Bldg 421 Construction Project for the removal & replacement of roof systems
- Complaints received from building occupants about particulate matter settling on work surfaces
- Samples taken of existing tar, pebble, & substrate roofing being removed
  - Higher than expected lead concentration
- Personnel relocated
  - Voluntary BLL analyses conducted
  - None exceeded recommended OSHA BLL of ≥ 40 µg/dl, very few above “background”

Background

- Subsequent comparison of original roof materials to samples taken
  - Suspicion that initial samples possibly included vent flashing material with high lead content, while other materials contain low or no lead
  - Low exposure risk from flashing, unlikely to crumble or pulverize enough to be inhaled or ingested
  - Some remote parts of the supply warehouse also had high lead levels in the settled dust, prompting considerations about previous leaded gasoline use, lead acid batteries, etc.
- *Bldg 421 investigation prompted questions about the presence of lead in settled dust and lead based paint in other JSC high bay buildings*

Standards

Occupational Lead Standards

OSHA	PEL 8hr TWA	50 µg/m^3
	Action Level 8hr TWA	30 mg/m^3
	BLL	≥ 40 µg/dl
ACGIH	TLV 8hr TWA	50 µg/m^3
	BEI	BEI: 30 µg/100 ml

Lead-Based Paint Related Standards

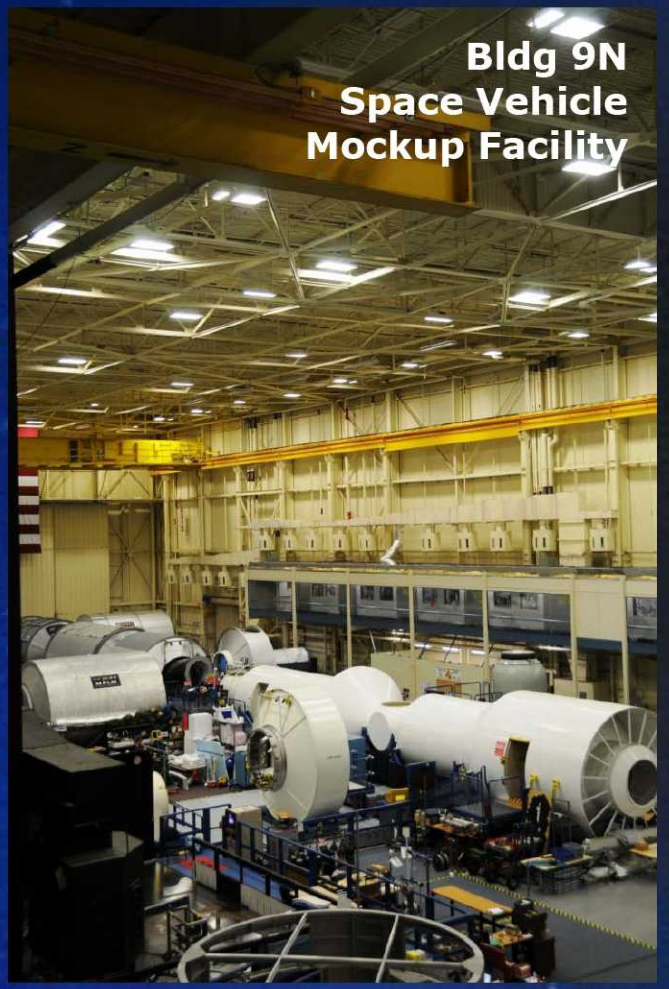
HUD	Title IV, Section 401, Residential Lead-Based Paint Hazard Reduction Act of 1992	0.5% (5000 ppm) > 1.0 mg/cm^2
EPA	Title X, Housing and Community Development Act, 1992	0.5% (5000 ppm) > 1.0 mg/cm^2
CPSA	Consumer Product Safety Act, CPSA 15 USC 2057-8, 1978	> 0.06%

Method

- Phase I – Surface Dust Sampling
- Phase II – Personal Exposure Monitoring
- Phase III – Paint Sampling

Phase I – Surface Dust Sampling

- Identified buildings with high bays that had not been abated
  - 14 buildings selected at random: Bldgs 7, 10, 13, 15, 24, 31, 33, 260, 321, 329, 350, 351, 352, 421
- 2 controls selected
  - Bldg 920L: built in 1997 after reductions in lead content taken
  - Bldg 9N: remodeled and cleaned in 1990's



Sampled Buildings

B33 Space Environment Effects Laboratory

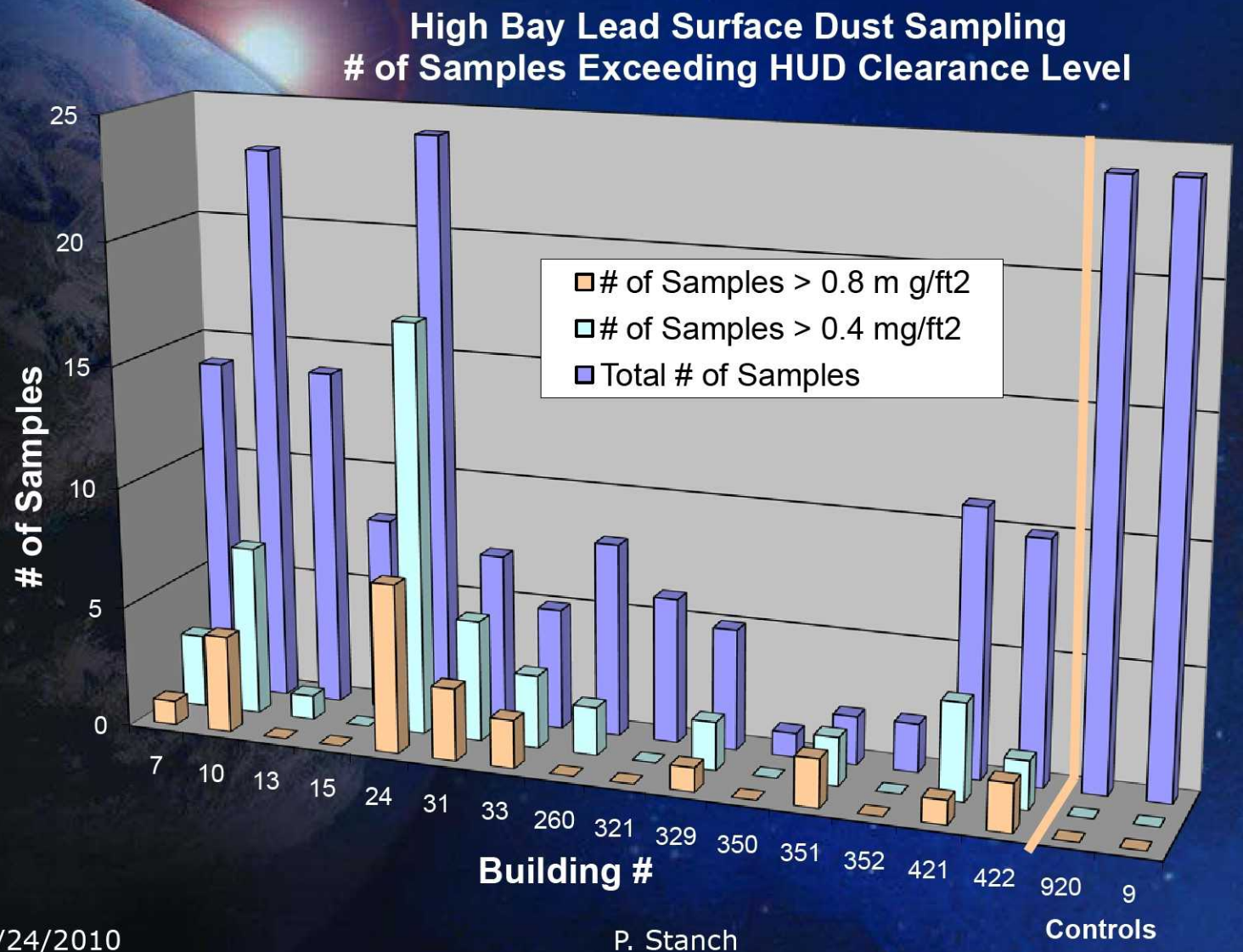
B31 Planetary and Earth Sciences Laboratory

B13 Structures and Mechanics Laboratory

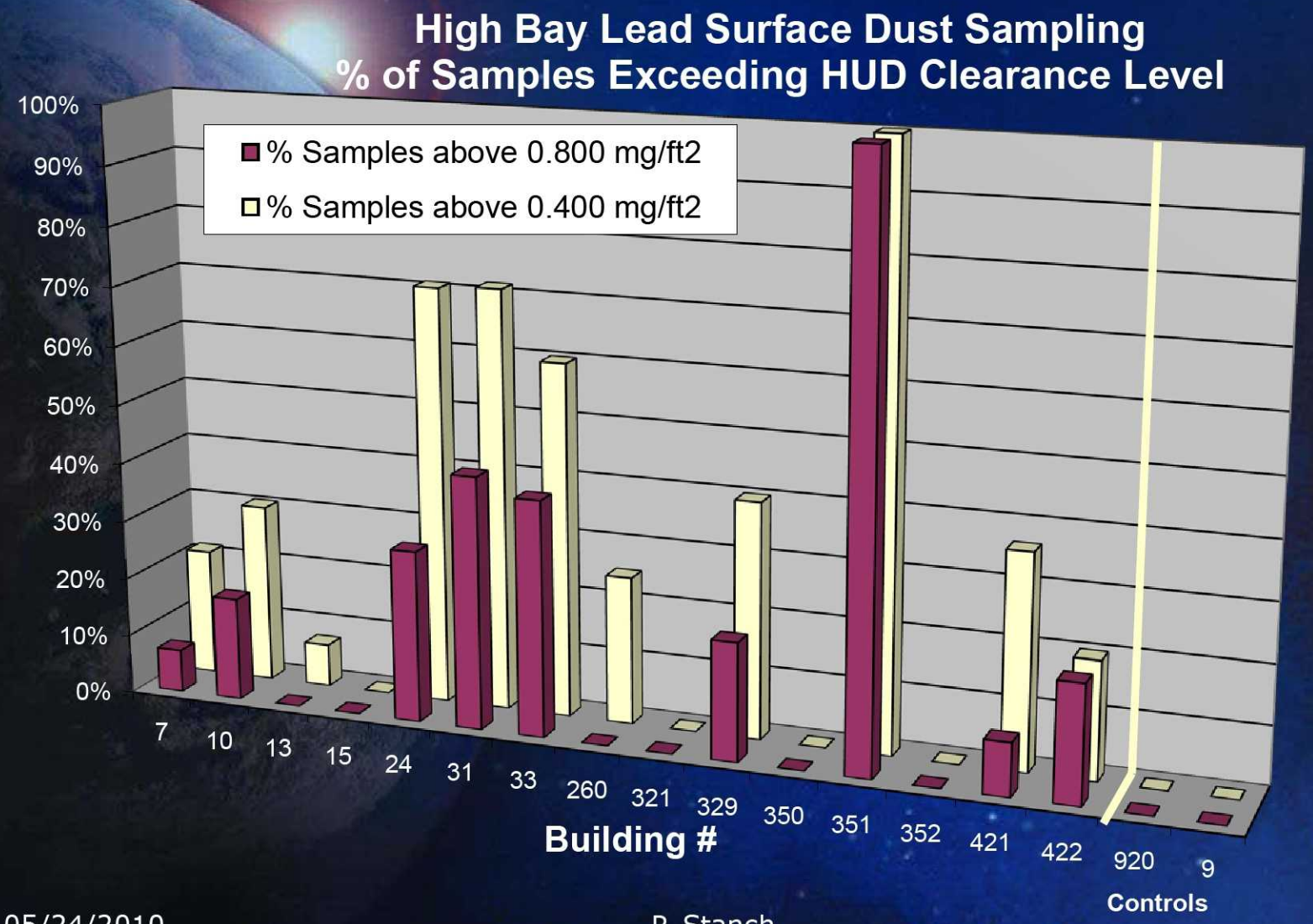
Phase I – Surface Dust Sampling

- Used EPA Lead Sampling Technician Method for collecting dust wipe samples in housing (EPA 747-B-00-002) Insert references
  - Analyzed per OSHA ID-121
  - Sample size ratio: 1 ft^2 sample/1000 ft2 floor space
- Compared to HUD lead-based paint risk assessment standard for clearance evaluation, 24 CFR 35.1320(b)(2)(i)
  - < 800 µg/ft^2 window troughs at study start in 2003
  - Lowered to < 400 µg/ft^2 in 2006

Phase I Results - # of Samples



Phase I Results - % of Samples



Phase II – Personal Exposure Monitoring

- Selected buildings with ≥ 1 sample exceeding 800 µg/ft^2 clearance level
  - Bldgs 7, 10, 24, 31, 33, 329, 351, 421
  - Added Bldg 422 to obtain a baseline prior to scheduled roof maintenance
  - Bldgs 9N & 920L used as controls

Phase II – Personal Exposure Monitoring

- Obtained at least 3 personal air samples per building
  - Monitored 3 people over a single day with exception of Bldg 351: the Alternate Facility Mgr was sole occupant, monitored him over 3 shifts
- Used OSHA Method # ID-121 Metal & Metalloid Particulates In Workplace Atmospheres (Atomic Absorption)

➔ *Bottom-line: All analytical results were below the detection limit of the method (Pb not detected)*

Personal Sample Results

Bldg	Duration (min)	Volume (L)	Analytical Results < (mg)
7	424	848.42	0.005
7	420	847.98	0.005
7	429	887.17	0.005
7	381	772.29	0.005
10	440	869.88	0.003
10	436	877.01	0.003
10	425	852.51	0.003
24	423	841.77	0.005
24	423	846.21	0.005
24	422	845.69	0.005
31	433	864.05	0.005
31	421	843.89	0.005
31	416	836.16	0.005
33	451	904.93	0.005
33	449	909.90	0.005
33	446	900.92	0.005
33	431	877.09	0.005
33	425	803.68	0.005
421	421	820.74	0.005
421	420	831.18	0.005
421	420	831.39	0.005

Bldg	Duration (min)	Volume (L)	Analytical Results < (mg)
422	416	827.42	0.005
422	422	844.84	0.005
422	419	838.84	0.005
329	430	862.32	0.003
329	426	856.69	0.003
329	427	840.98	0.003
351	419	829.41	0.005
351	420	829.29	0.005
351	421	826.21	0.005
Control Buildings			
9N	420	836.01	0.005
9N	375	746.44	0.005
9N	420	839.58	0.005
9N	419	852.67	0.005
920L	421	832.53	0.003
920L	421	849.37	0.003
920L	420	846.30	0.003

Phase III – Ceiling Paint Sampling

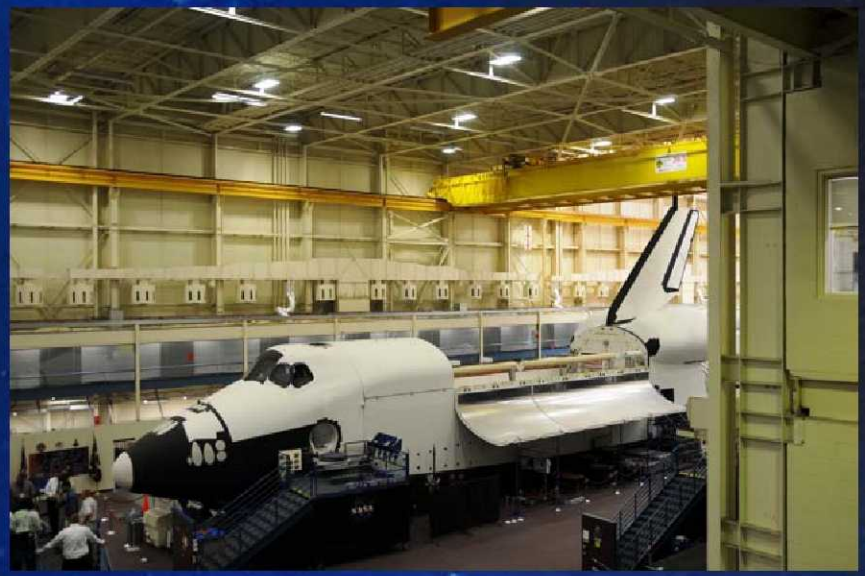
- To be performed per
  - TSCA Section 403: Sampling Guidance for Identifying Lead-Based Paint Hazards (EPA)
  - Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing (HUD)
- Work with Facility Maintenance and Operations Directorate to piggy-back on planned re-lamping activity in identified high bays or any other ceiling maintenance activity

Results: Phase I & II

- Surface dust samples indicate presence of lead in settled dust, but:
  - Personal exposure samples were below the detection limit
  - Likely accumulated over many years
  - Potential sources are many: deteriorated ceiling paint, gasoline-powered vehicles pre-dating unleaded fuel, lead-acid batteries & charging stations, metal alloys
  - Housekeeping and hygiene practices are providing appropriate mitigation against exposure
  - Lead awareness is addressed in Center-wide hazard communication and job-specific training

Phase III

- Recommendations:
  - Significant costs associated with sampling of ceiling coatings
    - Need for lifts, fall protection and training, facilities contract support, disruption of occupants' work, limited access
  - Given Phase II results, it was determined that there was little to no added value to sample paint
  - Evaluation of ceiling coatings is done on a project-by-project and a complaint basis



Current Process

- Monitor planned roof & abatement projects
  - Perform source sampling of coatings before project start
  - Specs intact do not permit use of lead-based coatings
  - Use current surface samples & personal exposure samples as baseline for comparison

References

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- OSHA, 2006. 29 CFR 1926.62 Safety and Health Regulations for Construction, Occupational Health and Environmental Controls: Lead. Washington, D. C.: Occupational Safety and Health Administration.

Acknowledgements

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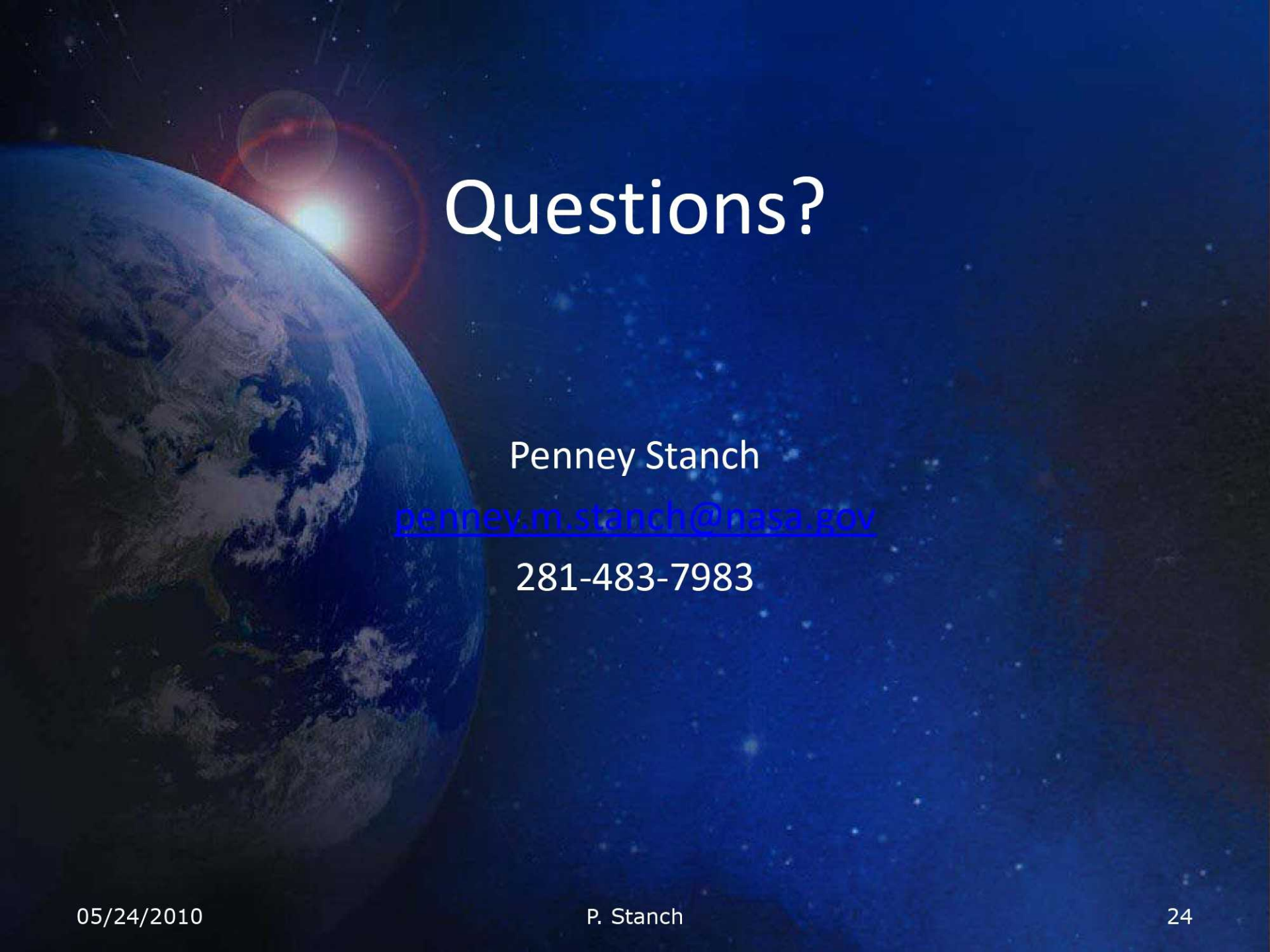
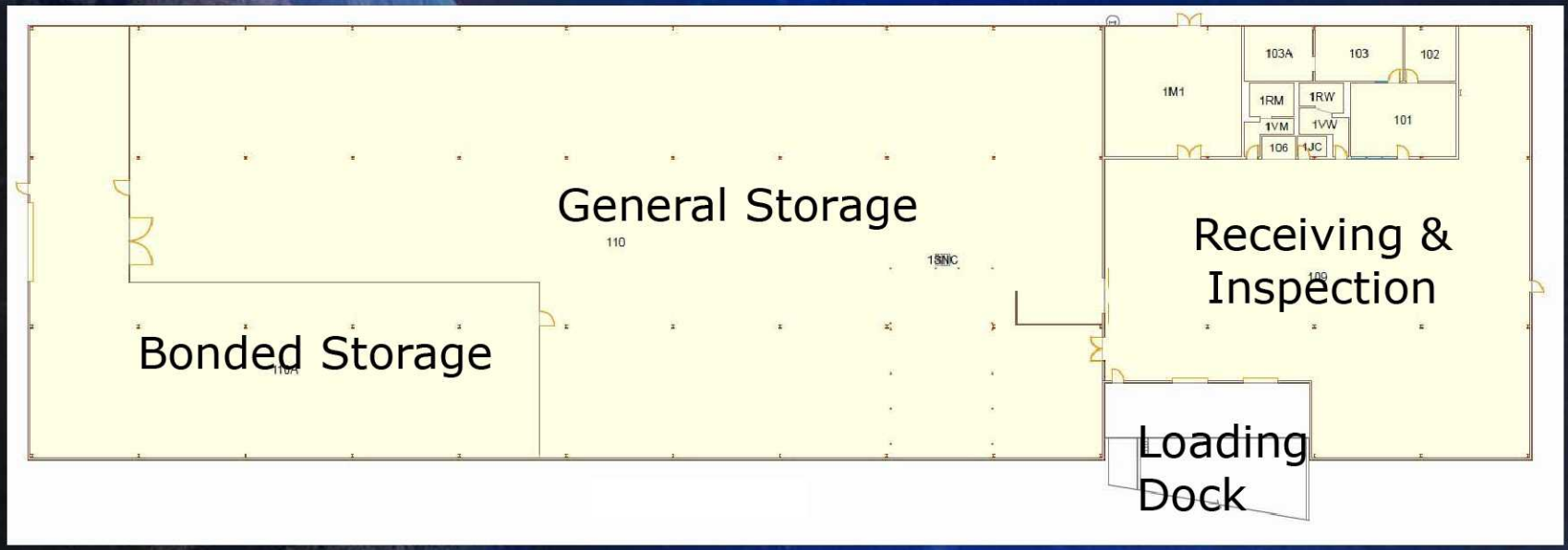


Penney Stanch

penney.m.stanch@nasa.gov

281-483-7983

Facility Housing Plan
Bldg 421 General Supply Warehouse



Sampled Buildings

Bldg #	Title
7	Crew Systems Laboratory
10	Technical Services Shop
13	Structures and Mechanics Laboratory
15	Experiments and Systems Laboratory
24	Central Heating and Cooling Plant
31	Planetary and Earth Sciences Laboratory
33	Space Environment Effects Laboratory
260	Training and Test Facility
321	Construction Materials Staging Facility
329	Maintenance Materials Staging and Shop Facility
350	Energy Systems Support Laboratory
351	Power Systems Test Facility
352	Pyrotechnics Test Facility
421	General Supply Warehouse
422	Logistics Support Warehouse
9N	Space Vehicle Mockup Facility
920L	Logistics and Mock-up Facility

Surface Sample Results

Bldg	Total # of Samples	# samples > 0.800 mg/ft^2	% samples > 0.800 mg/ft^2	% samples > 0.400 mg/ft^2
7	14	1	7.14%	21.43%
10	23	4	17.39%	30.43%
13	14	0	0.00%	7.14%
15	8	0	0.00%	0.00%
24	24	7	28.00%	68.00%
31	7	3	42.86%	71.43%
33	5	2	40.00%	60.00%
260	8	0	0.00%	25.00%
321	6	0	0.00%	0.00%
329	5	1	20.00%	40.00%
350	1	0	0.00%	0.00%
351	2	2	100.00%	100.00%
352	2	0	0.00%	0.00%
421	11	1	9.09%	36.36%
920	24	0	0.00%	0.00%
9	24	0	0.00%	0.00%
422	10	2	20.00%	20.00%